THE IMPACT OF COLOR ON LEARNING

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ABSTRACT

Color, significantly, has effects on human learning from birth. By utilizing color differences, individuals can engage with content more rapidly and develop a sense of connection. For instance, colors can exert various psychological effects on human life. Each color has a distinct impact, making understanding their applications crucial. Careful selection of colors in one's surroundings can substantially enhance learning, create a more conducive environment, and help address related challenges. This paper aims at investigating the ways that people can use colors to enhance learning. This library-based study was conducted by reviewing credible printed and online documents and sources. The findings of the study show that color influences many aspects of life. Utilizing colors can create better, more attractive environments for children and adolescents, fostering greater interest and enjoyment in their surroundings. The findings of this study can be applied to create engaging educational environments to enhance learning, motivation, and enthusiasm among students.

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1. Introduction

Color is a unique element through which symbols and secrets can be revealed by understanding its distinctions, properties, and effects (Azad-Kandehmahalleh, 2012). All material objects gain identity through color, which perpetually surrounds humanity, exerting influences (Taghavian, 2023). Color is a decomposable and known substance that imparts content and meaning to the human brain and eye, both physically and chemically. Understanding color is a psychological-physiological reality (Khandan-Del et al., 2008). Color is part of individuals' daily movement through life, gaining meaning from the colors in our environment (Karimzadeh et al., 2023). As humans constantly interact with colors, their importance is paramount (Tahapur et al., 2023).

Color influences brain waves (Rastegarpur, Yariyari, and Nazari, 2010). Generally, cool colors like blue, green, and purple reduce neural stimulation and induce calmness, while warm colors like red and yellow increase neural stimulation, motivation, and excitement (Sotudeh-Basari et al., 2023). Artists utilize the power of colors to display emotions such as compassion, arousal, and anxiety (Kalkali, Molazehi, and Damani, 2023).

Art cultivates qualities such as compassion, creativity, perseverance, patience, attention to beauty, and punctuality in humans, leading to inner refinement and the formation of good habits crucial for educating future generations (Maleki, 2021). Art can also restore hope and joy to people's lives (Nowruzi and Sooluti, 2018) and is among the most effective tools for human education today, significantly impacting creativity and mental health (Nabavi, 2013). Engagement with various arts creates mental tranquility and reduces stress

(Tajalli, 2021). Art education, especially for children, fosters a country's future development, with the educational system playing a fundamental role (Saravani and Saravani, 2021).

The story of color and its theory in art has oscillated between its reduction to the level of attraction or ornament and its valuation as the truth of painting (Gage, 1999). Accordingly, establishing a desirable connection between painting, coloring, and their everyday applications is essential (Fallahinia, 2023). Color is also a tool for reading, and painting serves as a voice, an instrument for reading and writing (Gage, 1999).

2. Color, Learning and Life

2.1. The Importance of Color in Everyday Life

Colors share a special closeness with human emotions and feelings (Akrami, 2005). Designing a safe and calm environment using colors requires attention to all spatial elements. Color affects objects and human conscious, subconscious, and unconscious dispositions, creating different behavioral reactions (Nasrollahzadeh, Ghasemi, and Kashef, 2016).

Experiments have shown that intense red stimulates the nervous system, increasing blood pressure and heart rate, thus acting as a stimulant. Conversely, intense blue lowers blood pressure and induces calmness (Ghasemi, et al., 2016). This function indicates that color, beyond its psychological and perceptual meaning, has physiological effects and can be considered a psycho-physiological phenomenon (Bakhtiarifard, Azimi, and Kabudi, 2014).

Experiments on children have shown they can distinguish colors from the first months of life. For instance, 15-day-old infants differentiate between red, yellow,

and green, and prefer red, yellow, blue, and green at older ages. By age 6, blue is recognized more than other colors (Nasrollahzadeh, Ghasemi, and Kashef, 2016; Eshagh-Davatgar, 2017).

Understanding color elements can be a mental and psychological step facilitating the perception and regulation of sensory information. This understanding is the first stage of perceiving the surrounding environment (Pakzad, 2006). As one of the most important visual constructs, color carries semantic and emotional aspects and has been used symbolically throughout history (Foruzanikhub and Banjouyi, 2017).

Johannes (1924) posits that the concept of color can be examined from three approaches: first, the degree of color influence based on culture and psychology; second, the stable meaning of each color for most humans (e.g., yellow as brilliance, red as heat, blue as boundlessness); and third, the position of colors in visual languages (Foruzanikhub and Banjouyi, 2017).

Color design does not follow fixed rules; environmental conditions, tools, and existing situations influence color choice. Research shows that entirely white spaces can cause lifelessness and stress; thus, using colors like green is recommended. Colors also have therapeutic applications. The history of color therapy dates back to ancient Egypt, where sunlight and colors were used to treat patients (Eshaghabadi, Koolivand, andKazemi, 2017). Today, color design in therapeutic centers must follow principles such as appropriate light and color contrast, harmony between colors, and attention to culture and environmental needs. Otherwise, incorrect color use can cause confusion and patient dissatisfaction (Shahri-Heravi and Sarchami, 2015; Eshaghabadi, Koolivand, andKazemi, 2017).

2.2. The Learning Process

Learning is a continuous process that persists throughout an individual's life. Learners have distinct learning styles, essentially developing strategies for reflection and behavior through various methods. Learning also utilizes a wide range of methods and mechanisms (Seyed-Ahmadi, 2019). Essentially, learning is the objective for which the education system provides numerous tools and strives to achieve. Certainly, judging the extent of solidified learning is difficult, but observing school and university graduates and reviewing their talents and proficiencies can indicate the status and efficiency of educational centers (Farokhi and Lohrasbi, 2022).

The most fundamental basis for any country's development is its education sector (Shahalizadeh, Dehghani, and Dehghanzadeh, 2014). Schools are small learning communities where students learn academic, educational, and social concepts, and also understand behavioral skills through interaction with teachers and other students (Abdolli, Zainodini-Mimand, and Ayati, 2017). If education aims to foster learners who can take responsibility for their learning, this distinction must first be instilled in educators (Sadeghi and Mohtashami, 2010). Thus, teachers must possess specific capabilities and competencies to achieve predetermined goals. Furthermore, if teachers employ innovative rules, they can expect more sustained learning from their students (Farokhi and Lohrasbi, 2022). Therefore, instead of focusing solely on learners' capacity, teachers should scrutinize learning methods, promoting learning freedom and learner proficiency (Sadeghi and Mohtashami, 2010).

Schools are established to develop comprehension and learning, as well as to generate added value in students' perspectives and influence (Grugan, 2013), making this impossible without teacher collaboration (Ambrose, et al., 2010).

We can conclude that the learning process refers to the teacher's engagement in teaching and learning, utilizing modern communication mechanisms and educational tools within learning centers, just like distance learning centers benefiting from e-learning, during selected learning intervals (Bakhshi, et al., 2014). Media and educational tools are capabilities that, if used sufficiently in the learning process, greatly assist students in conceptualization and knowledge construction. While striving to facilitate the learning pathway, we recognize the immense value of the educational environment and its effectiveness in nurturing learner creativity. We understand how, by respecting certain simple points in the design and architecture of classroom spaces, uch as appropriate color selection, window design for adequate light entry, etc., stimulation and interest in education can be created, leading to human success(Farokhi and Lohrasbi, 2022). It is also noteworthy that colors in textbooks play a significant role in the learning process.

2.3. Color Psychology

Color is an element beyond external recognition; it essentially encompasses what occurs in the mind and thus significantly influences actions (Zarei, Shoja'i, and Amani, 2021). Colors have stable outcomes and encourage reflections based on nature and social connections; they also transform the meaning of objects and their positions relative to their associations (Hamidavi, 2016). Essentially, colors are forces transmitted via wave methods. Photoreceptors in the retina send these forces to the brain, where color is ultimately perceived (Andrews, 2014).

The splendor and brilliance of a color alongside others make it more visible, and the proportionality between one color and others reveals its darkness or radiance (Shahri-Heravi and Sarchami, 2015). Depending on a color's lifespan and the conditions it benefits from, it may create contradictory concepts (Behnam, 2017). What we identify as color is essentially different wavelengths of sunlight transmitted into the retina, where color separation is performed by the eye. Rays

are separated into six distinct colors: red, orange, yellow, green, blue, and violet (Hamidavi, 2016). Kimballo, Beck, and Sandziyak (1978) believe the correlation between color and emotions is that yellow, orange, and blue are cheerful colors, while red, black, and brown are sorrowful colors.

Color psychology falls within psychological behavioral information, examining how color affects human actions (Hamidavi, 2016). Each color has its own characteristics:

* **Red:** A vibrant color symbolizing friendship, excitement, and cheerfulness. It enhances people's abilities, revives lasting enthusiasms, generates zest and excitement, and is even suitable for eye interiors (Shahri-Heraviand Sarchami, 2015). Red also represents existence, grandeur, and happiness but is not advisable for angry individuals (Eshaghabadi, Koolivand, and Kazemi, 2017).

* **Yellow:** In psychological knowledge, yellow is introduced as a cheering color (Hamidavi, 2016). Yellow can alleviate listlessness, worry, and tensions, and is causative in treating mental states and reducing neural irritations (Vernolia, 1988). Yellow is an attention-grabbing color that, by increasing body metabolism, stimulates appetite (Shahri-Heravi and Sarchami, 2015).

*** Blue:** Considered a cool color, blue not only creates a sense of comfort but also symbolizes discipline, friendship, and security. It soothes and calms the nervous system and is effective in reducing insomnia (Shahri-Heravi and Sarchami, 2015).

*** Green:** Symbolizes creation, health, fertility, and perfection. It reduces anxiety and eliminates fatigue. Combined with any pleasant color, it increases creativity (Hamidavi, 2016). Green has an immediate effect on all body nervous systems, particularly the central nervous system; it is soothing and reduces exhaustion.

Research reveals notable points about color combinations and their examination and understanding. One such point is that under red light, time seems

to pass excessively slowly, and objects appear large and heavy. Conversely, under blue light, time passes quickly, and objects seem lightweight and insignificant (Hamidavi, 2016). Using green and blue together induces cheerfulness because the sea and greenery alongside each other calm nerves and eliminate exhaustion (Eshaghabadi, Koolivand, and Kazemi, 2017).

Psychology states that cool colors like blue, green, turquoise, and silver have soothing properties, while warm colors like red, yellow, and gold can transmit different psychological states such as turbulence or agitation. Colors arising from combining cool and warm groups, like purple, lilac, violet, etc., are considered both sedative and passionate (Behnam, 2017).

3. Literature Review

Sheibani (2023) conducted a research on the impact of colorful decorations in educational spaces on learning, color recognition, and fostering motivation and creativity in students. The research method was action research, using fishbone diagrams and concept diagrams for data analysis. Data were collected through observation, interviews, and reviewing books and articles. Results indicated that classroom organization and attention to individual student differences significantly impact color recognition. Factors such as encouraging students towards teaching and learning, addressing student needs and interests, holding exhibitions and industry visits, utilizing students' scientific talents, involving students in class activities, and conducting workshops were effective in better learning and color comprehension.

Jamebozorg, et al. (2023) studied how colors and color images affect student learning and mood. This study used qualitative and quantitative methods to examine the role of colors in the learning process. Tools included standardized

questionnaires assessing color impact on mood, concentration, and learning, statistical analysis software, and psychological tools for evaluating behavioral and emotional changes. Results showed colors play a crucial role in increasing concentration, improving memory, and enhancing the learning process. Using appropriate colors in educational environments and resource design was suggested as an effective strategy for improving learning and reducing fatigue.

Ma'sumi and Daipur (2024) investigated the impact of light and color factors on student learning in educational environments, using mixed methods (qualitative and quantitative). Initial stages involved library studies and literature review. Specialists in environmental psychology, architects, educational space designers, and experienced teachers contributed. Tools included standardized questionnaires assessing environmental satisfaction and impact, direct observation of student behavior and performance, and semi-structured interviews with students and teachers. Light meters and color evaluation tools were used to analyze physical space conditions. Results showed appropriate lighting and optimal color use significantly impact learning, behavior, and student morale.

Noorpoor, et al. (2023) conducted a research on the impact of colors on student learning, using library research and descriptive-analytical methods. Guidance from professors and specialists in educational psychology and teaching was utilized. Opinions and experiences of teachers directly involved with students influenced data analysis and conclusions. Tools included library resources, scientific articles, psychology and education databases, and analytical software for qualitative data examination. Results indicated colors play an important role in student learning processes. Correct color application in educational environments can improve student growth, flourishing, and learning.

Khezri, Torknezhad, and Torknezhad (2023) studied the impact of color psychology on student learning, using qualitative and quantitative methods.

Teachers and school principals participated as research collaborators, and students from several schools were selected as samples. Educational psychologists and interior designers specializing in learning environments served as scientific consultants. Tools included standardized questionnaires assessing concentration and motivation, statistical analysis software for quantitative data, and qualitative content analysis software for interview and observation data. Optical and thermometric equipment controlled environmental conditions during experiments. Results showed using dark and attractive colors can increase student motivation and enthusiasm, while bright and vivid colors improve concentration. Properly designed learning environments addressing students' psychological and physical needs significantly impact learning quality.

Mirhabibi and Minayi (2022) investigated the impact of classroom color on concentration and learning of male third-grade elementary students, using a scientific-comparative method. Contributors included teachers, principals, and the research team. Tools included questionnaires assessing concentration and learning levels, standardized tests comparing scores and learning levels in differently colored classrooms, and statistical software for data analysis. Results showed blue had the most positive impact on attention, concentration, and learning compared to white and other colors, more effectively improving academic performance. These findings can inform the design of more suitable and effective educational environments.

Zaheri (2022) researched the impact of color on children's learning, evaluating the effect of colors on behavior and learning through various colored environments, including clothing, walls, and objects. The research analyzed the role of primary colors like red, green, and blue in accelerating learning and strengthening memory. Contributors included color psychology researchers, education specialists, and teachers. Tools included environmental observations, behavioral tests, and performance assessments in educational and everyday

settings. Results showed colors significantly impact children's behavior and learning. Primary colors like red, green, and blue can accelerate learning and enhance memory performance. Appropriate color use can increase children's attention span and motivation.

4. The Impact of Color on Learning

Color greatly impacts children's learning and mentality. Primary colors like red, green, and blue can influence learning progress. Children constantly seek a colorful world for themselves, which can significantly aid learning advancement. Colors are highly effective in strengthening memory performance, and using appropriate colors suitably enhances children's attention span (Zaheri, 2022).

Learning increases through the use of colors (Shokuhiasl, 2018), and colors have shown considerable effect on the outcomes of student learning (Noorpoor, et al., 2023). Student learning depends heavily on colors. The goal of education is student learning, which itself depends on the presence of cheerful colors. Light blue, yellow, green, and orange enhance children's learning performance, increasing it by up to 12 points (Bahamin et al., 2013). Colors impact learning by forming a system that leads to distinguishing important and unimportant elements in the environment, making them easier (Nejati, 2014).

Psychologists emphasize the importance of healthy emotional development and creativity, both originating from childhood learning. Emotional and cognitive issues and the influence of colors in childhood can change children (Kalkali, et al., 2023). Designs and colors in textbooks significantly impact student learning stages; appropriate designs and colors can aid in improving student learning (Mofidi, et al., 2023).

Researchers believe color is the most effective visual experience for humans, functioning as a strong information network with the human cognitive system, greatly influencing the speed of mind and memory function (Zarei, et al., 2021). Colors affect students both mentally and physically (Rashidi, et al., 2023). Colors can be effective in creating enthusiasm among students for learning and utilizing their educational experiences (Zarei, et al., 2021). Using calming colors like blue and green in individual study spaces and energetic colors like red and orange in group work areas has positive effects on learning and motivation (Rahimpur, et al., 2023).

Color, as the most important feature in educational environments, can influence students' internal efficiency (Jaideri and Jafarikhah, 2008). Color in educational environments creates cheerfulness, vitality, activity, and challenge among students, speeding up learning stages (Rajaei and Jafarikhah, 2008). As understood from this research, color is an influential factor on morale, learning stages, and behavior in educational environments (Ebrahimizadeh and Jafari-Foutami, 2016).

Using different colors in classrooms and educational tools enhances learning and helps solidify information in students' minds (Tahapur, et al., 2023). Patterns and colors in classroom environments influenced the advancement of motivation for class attendance and enthusiasm for learning in secondary schools in Qom (Yusefi, et al., 2023).

5. Strategies for Enhancing Learning with Color

5.1. The Learning Environment

Students spend most of their time learning in schools, thus requiring a place to compensate for their boredom (Hasheminia, 2017). This environment must provide facilities for discovering inherent abilities and powers

(Nasrollahzadeh, Ghasemi, and Kashef, 2016). If a child grows in an unreasonable space, they benefit little from divine power, and other difficulties arise in this same unreasonable space (Hosseini, 1997). Consequently, the most important issue in schools and learning is the space students engage with daily, akin to a second home where they study and effectively live. A recent challenge is creating equal and feasible environments for students of all ages and grades. Examining various European examples reveals they have developed methods of design, color usage harmonized with sunlight, and various returns in student learning (Ahmadi-Bafarajerd, 2023). Using different colors in classrooms accelerates learning and enhances student memory for lessons (Tahapur, et al., 2023).

The most prominent colors for children are red, orange, yellow, and blue. Children do not pay attention to colors like gray, black, brown, and white and have no interest in them, as these colors cause them distress. Therefore, teachers and educators in preschools should consider color psychology to be more careful in determining the color of learning spaces and even their own and the children's clothing (Hasheminia, 2017). To enhance student and other individuals' learning after familiarization with colors, the following strategies can be employed for the environment:

* Arranging chairs and desks based on color in classrooms: Disorganized, messy arrangement without interesting colors or incorrect color scheme drains student energy for learning, reducing interest in sitting in class. Chair arrangement based on color should prevent the environment from appearing small and crowded.

* Using primary and some secondary colors on classroom walls: Primary colors have lasting, positive effects. Yellow, green, orange, and light blue are also popular among students. Using these four colors in classroom design increased students' IQ and learning scores by 12 points. However, designs using white, brown, and black lowered scores (Hasheminia, 2017). Therefore, using the mentioned colors in classrooms can easily increase learning.

* Creating a cheerful space using diverse high-wavelength colors: Kindergarten environments should be designed using various colors to encourage children to stay. Using high-wavelength colors like red, yellow, and green not only creates a lively, beautiful environment but also encourages children's visual power (Jalili, et al., 2016).

* Creating strong contrast on classroom surfaces: Color and contrast are passionate and experienced tools for designing school spaces, requiring sustained contrast between surface layers (Eshaghabadi, K00livand, and Kazemi, 2017).

* Using cool colors in classrooms: Using cool colors with low wavelength is also recommended, as they lower body temperature and create a soothing, contemplative environment for student comfort (Nasrollahzadeh, Ghasemi, and Kashef, 2016).

* Creating modern architecture favored by students: One effective educational structure in new teachings is the method of designing and architecting schools and classroom environments (Jafarifoutami and Ebrahimizadeh, 2016). Classroom design and color use in layout and architecture should create a modern, beautiful compound where students do not feel exhausted and attend to lessons willingly.

5.2. Learning Tools and Utilities

The psyche of students and adolescents, due to their age and mental conditions, is more susceptible, as it can bring cheerfulness, freshness, mental peace, excitability, and effort, increasing learning steps—just as it can cause boredom, inactivity, sensitivity, anxiety, and depression (Khalesi, 2003). Some research indicates that using color in educational tools will not enhance learning unless the color is directly related to what is being learned. The impact of color on learning is not exclusive to children; colors affect adults in several ways. Colors

should also be used in university educational environments and classrooms to aid student learning. Strategies for enhancing learning through tools include:

* Using different colored markers on the board: Using educational tools with different colors, e.g., using different colors on the board, one color for answers, another for solutions, increases student motivation for learning.

* Displaying numbers on different colored paper: Using colors in teaching lessons helps students better understand materials. For example, numbers or letters can be written on differently colored paper for instruction, helping students remember colors well and providing enjoyable entertainment.

* Using cheerful colors in books and texts: In science books, green can be used to increase curiosity and blue to strengthen focus. For social studies, orange can enhance sense of participation, and green can increase curiosity for teaching our country's history.

* Using bright colors on desks, chairs, and other classroom items: Bright colors, particularly warm ones like red, orange, and yellow, increase mental awareness and enhance specific activities like IQ. Therefore, these colors should be used more frequently in schools with color variations.

* Providing comfortable ergonomic chairs in classrooms: Students need a peaceful environment and comfortable tools for learning. Using chairs that prevent fatigue, allowing easy listening without tiredness, significantly impacts better learning and increases it.

* Using negative contrast for textbooks: Reading requires colors with high contrast between text and background. Black text on white background is positive contrast; white text on black background is negative contrast. Research results show performance using negative contrast is equal to or even better than using positive contrast (Shen, et al., 2009).

* Using colorful and varied images in textbooks: Using images like cells, laboratory equipment, mines, resource extraction tools, etc., in textbooks (e.g., science books) makes them more attractive and increases student enthusiasm.

* Using purple for art books: Using purple in art and design books can strengthen imagination and lead to better creative works.

* Teachers avoiding brightly colored clothing: Teachers should wear clothing that does not distract students, promoting greater attention to the taught material, rather than colorful clothes.

6. Conclusion

Humans used colors from birth without knowing their effects. Today, with scientific advancement, color is used in various places like hospitals, educational centers, restaurants, etc. Colors possess psychological properties, each harboring specific characteristics. Colors significantly impact many matters, including memory enhancement and increased learning, fostering motivation and creativity. Research indicates that individual or group teacher attention greatly influences increased learning. It is noteworthy that men show more interest in blue than other colors, leading them to prefer places where blue is used more. Women prefer soft colors and react more to them. Each color affects us differently: blue enhances concentration, red improves attention to details, green stimulates curiosity, orange is suitable for class participation, yellow highlights important information, and purple strengthens imagination. Ultimately, research shows colors significantly impact many aspects of human life, and humans are highly dependent on colors. Without colors, the beauty of creation would be invisible, and writing and studying would be impossible.

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